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ABSTRACT

While the demand for increased educational productivity is clear, the methods for achieving it are largely undetermined. Cost effectiveness techniques have proved to be valuable tools for commercial organizations, but the relevance to educational problems is less than clear. Theory suggests that these techniques can be useful for dealing with small, specific educational problems. (A study of large scale simulation models for university planning concluded that the cost required to implement the model exceeded the savings achieved through the use of the model.) Cost analysis is possible only where objectives can be stated and where more than one method can reach those objectives. Although some educators deny it, this situation does exist in education. At present, however, evidence indicating the reliability and accuracy of cost effectiveness techniques applied to instructional systems simply does not exist. Empirical data on this question is needed. The technique must be applied before it can be judged. The test of its worth is whether money is saved or lost. (JK)

A STUDY OF THE APPLICABILITY OF COST EFFECTIVENESS TECHNIQUES TO SMALL SCALE INSTRUCTIONAL SYSTEMS

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> Finance has overtaken discipline as the major problem of our public schools, according to an opinion poll conducted by Gallup International. The Third Annual Survey of the Public Schools found some changes in what the public believes to be the most important problems facing schools today, as well as differences in opinion among the various groups surveyed. Although financing school operations was listed as the most important problem in 1971, fifty-two percent of the voters questioned are opposed to raising taxes. On the other hand, they are largely opposed to cutting services already offered by schools. . . Approximately half the public favors performance contracts and management experts to assure they get their money's worth from school operations. . . Implicit in the public's concern with financing and performance contracting is its endorsement of methods which can guarantee high standards of education at low costs.
>
> (National Association of Educational Broadcasters, 1972, p. 1)

The results of this poll make it quite clear that the American public desires an increase in educational productivity. The public expects the education industry to provide the same services currently offered with the same number of dollars currently provided even though the purchasing power of these dollars is diminishing at an annual rate of approximately five percent ("Wages and Prices," 1971). Although it is not uncommon for corporate managers to demand an annual increase in productivity, it is rather unusual for educational administrators to make these same demands (Bowen, 1969). This, however, must change if the public is to be satisfied.

This demand for increased educational productivity is not only reflected in public opinion but is also manifested in several recent educational developments. Performance contracting schemes in which a school subcontracts with a private firm for those services which the school finds most difficult and most costly are examples of attempts to increase productivity (Bruno, 1972). The voucher plans which allow students to purchase education from competing schools is another attempt to force schools to increase their productivity (Boulding, 1972). These voucher plans place students in the role of education consumers who will hopefully try to buy the most education at the lowest price. The schools, on the other hand, are education producers who must manufacture a competitive product at a price the market will bear. Under the voucher plans, the schools are forced to assume the same role as the private firms under performance contracting schemes.

While the demand for increased educational productivity is clear, the methods for achieving increased productivity are largely undetermined. While cost studies in education date from the scientific management movement of the early 1900's (Cooke, 1910) to the school finance equalization studies of the 1970's (Hickrod, et.al., 1972), these studies have been primarily concerned with the determination of the cost of education, the relationships between cost and quality, and methods for determining equal distribution of the educational dollar. Consequently, excellent procedures are available for determining the amount a given institution spent to produce a given number of graduates (Read, 1964; Evans and Hicks, 1962). Truly elegant models are available for the distribution of educational dollars throughout a state or school district (see Hickrod, 1971). These studies, however, were not designed to discover methods which allow

schools to produce the same amount of services while reducing costs.

Commercial organisations faced with the problem of increasing productivity while maintaining or reducing costs utilize cost effectiveness or cost simulation techniques to evaluate alternate methods of production and to select the most appropriate method of production for their organisation under a given set of market constraints. Basically these models compare various alternate methods of producing the same product. Comparisons are made on the number of units which can be produced in a given period; the resources required to produce each unit; the availability of the required resources; the cost of each unit; the predicted number of unit sales at various price levels; and the loss incurred by not using the available resources in another manner. The value for each of these factors for each method of production is generally specified by a cost accountant. Since he is dealing with proposed rather than operating production systems, the cost accountant must estimate or predict these costs. Naturally, the validity of the comparisons are directly related to the accuracy of the predictions. Once the costs have been estimated, the various production methods are compared and analysed by a computer utilizing either a linear or a dynamic programming technique. The results of the comparisons are then used by management as the basis for selecting the most appropriate production technique. (For a more complete discussion see Carsberg, 1969.)

While cost effectiveness or cost simulation techniques have proven to be very valuable tools for commercial organisations, their relevance to educational problems is less than clear. In theory, the concept of simulation seems applicable.

> An educator may ask whether expensive teaching devices will be worth their cost to his students. The final answer to any such questions must be found by experimentation done in the classroom under classroom conditions. However, the classroom is an expensive, inconvenient, and inflexible laboratory. The one final way to decide whether a bridge will stand is to build the bridge and see; but it is not sensible to build twenty bridges of various weights and types of construction to see which ones stand. Instead, laboratory studies and theoretical analyses are used to calculate what constitutes the best bridge. . .Combined with suitable mathematical theory, laboratory data can be used to answer questions about educational practice and to plan reasonable educational programs.
>
> (Restle, 1964, p. 111)

Nevertheless, Hopkins (1972), after reviewing the literature on the use of large scale simulation models for university planning, concluded that the cost required to implement the model exceeded the savings achieved through the use of the model. Hopkins' argument is based primarily on the huge cost of assembling and processing the data the model requires. However, Hopkins also feels that "a model with only 10 or 20 decision variables can be far more instructive than the large-scale models. . . (p. 477)." McNamara (1971) echoed Hopkins' thoughts by stating "mathematical applications to management should stay clear of large general models and concentrate on specific problems (p.440)."

The belief that cost simulation techniques can be useful tools for dealing with small, specific educational problems rests largely on theory.

> In light of the prevailing emphasis on systems analysis in education, there is an emerging literature that advocates the use of management science and operations research models as a means to increase the efficiency of educational planning and decision making (Knezedich, 1969). Too often, however, the intent of these articles is to focus on the advantages of applying models rather than to provide empirical research that illustrates the unique contributions of such models in generating solutions for real and immediate educational problems.
>
> (McNamara, 1971, p. 420)

Although empirical evidence is lacking, the theoretical base is both reasonable and impressive. However, the theoretical structure rests upon assumptions which many educators may find less than pallatable.

The use of a cost effectiveness technique requires the ability to generate several different methods of achieving the same objectives (Nathanson, 1972). These methods are then analysed to determine which can be implemented at the lowest cost. This method is then considered to be the most cost effective. For example, the goal may be to determine the most cost effective method for teaching a course. Method variables would include class size and instructional variables such as the use of laboratories, videotaped lectures, programmed texts, and computer aided instruction. However, a cost analysis can not be applied to a situation where the objectives can not be stated or when there is a conviction that one and only one method can be used to achieve the objectives. The use of cost effectiveness analysis, therefore, assumes objectives and several viable means for achieving these objectives.

While many educators may find these assumptions untenable, they are supported by substantial theory and empirical evidence. Both Mager (1962) and Popham (1968) have presented impressive theoretical arguments for the use of objectives. According to Gagne (1970),

> First, no single medium is likely to have properties that make it best for all purposes. When effectiveness of one medium is compared with another for instruction in any given subject, it is rare for significant differences to be found. Lectures have been compared with reading, lectures with motion pictures, pictures with text, and many other kinds of comparisons have been made without revealing clear superiority for any given medium. . . Over a period of years, researchers have learned to be skeptical of single instances of reported statistical superiority of one medium versus another.
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> Most instructional functions can be performed by most media. The oral presentation of a teacher can be used to gain and control attention, but so also can the use of paragraph

> headings in a textbook, or an animated sequence in an instructional motion picture. The learner can be informed of the expected outcomes of instruction by a printed text, by an oral communication, or in some instances by a picture or diagram. Recall of prerequisite learned capabilities can be done by oral communication, by means of a sentence or picture in a text, or by a movie or television pictorial sequence. Similar remarks could be made about every one of the functions of instruction described in this chapter. . .the most reasonable generalization is that all media are capable of performing these functions.
>
> In general, media have not been found to be differentially effective for different people. It is an old idea that some people may be "visual-minded" and therefore learn more readily from visual presentation, while others may be "auditory-minded," and therefore learn better from auditory presentations. While a number of studies have been conducted with the aim of matching media to human ability differences, it is difficult to find any investigations from which one can draw unequivocal conclusions.
>
> (pp. 363-364)

Gagne's findings certainly support the assumption that various alternate methods may be used to achieve the same instructional objectives. Therefore, when viewed from a theoretical perspective, cost effectiveness techniques appear applicable to instructional situations with clearly specifiable objectives such as classroom instruction.

When viewed from a practical perspective, on the other hand, the applicability of cost effectiveness techniques is far from evident. First and foremost, utilization of the technique must save more than it costs. This means that the technique can be accurately and reliably used to identify the least expensive method of achieving a given set of objectives; that the method identified can and will be implemented; and that the resulting savings will be greater than the cost of utilizing the technique.

Evidence indicating the reliability and accuracy of cost effectiveness techniques applied to instructional systems simply does not exist. This

evidence can only be generated by the successful application of the technique. On the other hand, no unsuccessful attempts have been reported. The accuracy and reliability of the techniques when applied to corporate activity have been documented (Vance, 1959). But the corporate cost accountant who is well trained in the art of predicting the cost of various alternatives has, as yet, no educational counterpart. Also, the corporate and educational environments are not identical. Therefore, until either success or failure has been documented, the educator who wishes to employ the technique must proceed armed only with faith in both cost effectiveness and his ability to employ the method.

Even if cost effectiveness is a valid technique which can reliably identify the least expensive alternative, the exercise is not worthwhile unless the alternative can and will be implemented. A sophisticated analysis which produces recommendations which are ignored benefits no one. If this occurs, the resources allocated for the analysis have been wasted and the productivity of the entire system has been lowered. In short, the use of cost effectiveness techniques in a hostile environment may be counter-productive. (See Smith, 1971.)

Since cost effectiveness techniques have not been applied to instructional systems, their ability to generate savings remains to be verified. The criteria, however, are clear. The cost of utilizing the technique plus the cost of implementing the least expensive method must be less than the cost of the method which would have been selected if the technique had not been employed. It is conceivable that educational decision makers intuitively select the least cost method (Elmore, 1953). If this is true, cost effectiveness techniques represent only an unnecessary,

additional expense. This is a researchable hypothesis which demands exploration.

Is the application of cost effectiveness techniques to small scale instructional systems cost effective? This is an empirical question which can not be answered with existing data. Instead, it must be answered with what must be viewed as highly subjective and highly tentative opinions. The feeling that cost effectiveness techniques can be effective in small scale instructional systems may simply be an erroneous conclusion drawn from the juxtaposition of the idea that cost effectiveness is a valuable managerial tool with the opinion that cost effectiveness is inappropriate for large scale instructional systems. On the other hand, a careful examination of the differences between large and small scale systems seems to indicate that the techniques may be more viable in the small system.

The most obvious difference between a cost effectiveness study of an entire college and a study of a single course lies in the mass of data which must be handled. The number of alternate methods for the operation of a college vastly exceeds the number of methods of teaching a single course. Since a larger number of alternatives requires a larger number of predictions, the probability for error is greatly increased. With a large mass of data and a complex analysis, these errors may become camouflaged and difficult to detect. A smaller system should be easier to monitor and errors should be easier to detect. Inherent in these arguments is the assumption that the economy of scale is not operational and that, in fact, diseconomy of scale will be the rule rather than the exception. This appears appropriate and is not unprecedented (see Hirsch,

1960). The costs associated with data analysis, for example, would be imporportionately larger for the large scale system because of the necessity for designing special computer programs. The small system most probably can be analysed with unmodified, existing library routines.

The comparison also reveals the inappropriateness of the application of cost effectiveness to large scale instructional systems. First, few colleges or other large systems have a complete set of clearly specified objectives. Second, since the operation of a large scale instructional system involves the cooperation of many semi-autonomous decision makers, resistance to the changes recommended by the analysis may be quite formidable and difficult to overcome. The difficulty of achieving consensus within a group of semi-autonomous decision makers is probably another good example of the diseconomy of scale. Determination of the cost effective method for a subsystem such as a single course can be much less of a problem, especially if the objectives of the subsystem are clearly specified and the decision makers involved are enthusiastic. The probability of discovering a subsystem with these attributes is far greater than the probability of discovering a large scale system with similar attributes.

The concept of applying cost effectiveness techniques to instructional systems is still in its infancy. It is not amenable to evaluation by philosophical consideration. The technique must be applied before it can be judged. The criteria is quite simple -- either money will be saved or money will be lost. This will be the test of its worth.

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